

Bioindicators and Circular Strategies in Environmental Studies: Pollution Assessment, Apicultural Products and Waste Cooking Oil Valorization

Abstract

Fundamental research in the field of environmental science is of major importance as it provides new, clear, and evidence-based information regarding the state of ecosystems, the level of contamination, and the impact of anthropogenic activities on environmental factors. These studies contribute essentially to the understanding of environmental degradation processes and to the identification of sustainable directions for the protection and valorization of natural resources.

The habilitation thesis, entitled “*Bioindicators and Circular Strategies in Environmental Studies: Pollution Assessment, Apicultural Products and Waste Cooking Oil Valorization*”, summarizes the main results of my scientific activity conducted after obtaining the PhD title, as well as the professional path developed in the field of environmental sciences, with an emphasis on pollution assessment and the development of solutions based on circular economy principles.

There are three major research directions addressed in the habilitation thesis. The first focuses on the assessment and monitoring of environmental pollution, with particular emphasis on water quality in pollution-affected areas (Alba County), including the use of diatoms as bioindicators for assessing surface water pollution, as well as research on soil quality in polluted areas.

The second direction concerns apicultural products as bioindicators of environmental pollution and microbial bioinhibitory agents, highlighting the role of honey and propolis in reflecting environmental contamination and their potential antimicrobial properties.

The third direction explores the circular valorization of waste cooking oils into antimicrobial soaps, integrated with environmental risk assessment under the ISO 14001 framework, by incorporating apicultural products and essential oils into sustainable formulations and valorization strategies.

The research directions addressed primarily focused on the assessment of environmental quality factors, especially surface and groundwater in areas subjected to anthropogenic pressure. The studies aimed to identify spatial and temporal variations of quality indicators (physicochemical and microbiological parameters), as well as to highlight pollution sources. In this context, bioindicator organisms—diatoms—were used as efficient tools for assessing the ecological status of aquatic ecosystems, due to their high sensitivity to environmental changes, evidenced also by the occurrence of teratological (abnormal) forms, frequently associated with ecological stress and pollution.

Another important direction was the analysis of soil contamination, particularly in areas affected by industrial and mining activities, through the determination of heavy metal concentrations and the assessment of associated ecological risks. These studies contributed to the understanding of pollutant accumulation and transfer mechanisms in the environment and to highlighting their long-term impact on ecosystems.

In parallel, I investigated apicultural products (honey and propolis) as bioindicators of environmental quality, focusing on how pollution influences their composition, safety, and biological activity. The results highlighted correlations between the degree of environmental contamination and the characteristics of these natural products, confirming their usefulness in

integrated environmental monitoring.

A complementary research direction focused on the valorization of organic waste, particularly used cooking oils, through the development of circular strategies for their conversion into value-added products, such as soaps with functional properties. These studies included the use of bee products and essential oils as ingredients, the optimization of conversion processes, and the assessment of environmental impacts within a production facility, in accordance with the principles of sustainability and environmental management.

The conducted research contributes to an integrated understanding of environmental issues by combining pollution monitoring methods with innovative resource valorization approaches, supporting the transition towards sustainable development models and a circular economy.